

A REVIEW OF THE INDIAN OIL SARDINE FISHERY.¹

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INTRODUCTION.

It is well known that the European and American herring, pilchard, sardine, etc., make the largest contribution to the fisheries of the world, and are the mainstay of the economy of most of the European maritime nations. The French expression 'la crise sardinière' is a measure of the disastrous effect of the failure of the fishery to the nation. The pioneering fishery researches of Scandinavian countries to elucidate the causes of the periodical failure of the herring fishery indicate the importance attached to this fishery. The 'iwashi' or Japanese sardine yields more than a million tons during a normal season in a year. The sardine fishery of the Pacific Coast of North America came to prominence as a result of the stress of World War I and contributes the largest output of any single fish in the State of California.

In Indian waters, the clupeoids are chiefly represented by sardines, anchovies and whitebaits, of which the oil sardine, *Sardinella longiceps* Cuv. & Val., ranks as the most valuable and highly priced fish in the economy of the West Coast of India, from Ratnagiri in the North to Travancore in the South. From the Malabar Coast the sardine oil and manure were exported for over a century and the fish has been rightly referred to as 'Kudumbam pularthy' (provider for the family) in the Malayalam language.

The fluctuations in the Indian oil sardine fishery were similar to those of the herring and sardine fisheries of Europe, America and Japan, with the yields undependable. The abundant occurrence of oil sardines all along the West Coast and their use as food and manure had been known from very early times. Odoric² was probably referring to the oil sardines when he observed, during his visit to Ceylon about the year 1320, that 'there are fishes in those seas that come swimming towards the said country in such abundance, that for a great distance into the sea nothing

¹ Published with the permission of the Chief Research Officer, Central Marine Fisheries Research Station, Mandapam Camp and the Director of Fisheries, Madras.

² Cited by Day (1865).

can be seen but the backs of fishes, which, casting themselves on the shore, do suffer men for the space of three daies to come and take as many of them as they please'. Nieuhoff¹ also noted in 1673 that the oil sardines were abundant off Malabar and Ceylon. Dussumier,² in the year 1827, observed in Malabar the sardines being used as manure for paddy and coconut palms as they were unfit for salt-curing owing to excess of fat. Day (1865) remarked that 'it is only of late years, since animal oils have become so dear, partially due to a deficiency of that of the whale, that attention has been directed to the immense shoals of sardines, which are found off Malabar and Ceylon'. He also observed that until after the middle of the 19th century the sardines were largely used for manuring coconut plantations and paddy fields, for feeding pigs and poultry and for manufacturing oil, while a comparatively small proportion of the catches alone was consumed by the local population. Judging from the annual average value (£7,000) of export of sardine oil from Malabar to Europe and other places, it would seem that these fishes were caught mainly for oil. The high price of oil sustained the industry on the West Coast of India, but Day foresaw the ill-effects of unrestricted fishing in diminished catches in later years. He also thought that the oil sardines 'occasionally forsake their haunts for several consecutive seasons, returning again in enormous quantities'. Thurston (1900) attributed the declining trade in oil to irregularity in the appearance of sardines. Nicholson (1915) suggested the revival of the oil industry on more rational lines.

FISHERY.

The oil sardine fishery is restricted to a 8 to 10 mile broad strip of the inshore waters off the Kanara and Malabar Coasts, owing to the small size of the craft used for fishing such as the dug-out canoe. The size of tackle used had naturally some relation to the size of craft employed, but within the implied limitations, maximum efficiency for capturing the shoaling oil sardines in inshore waters was attained in the course of several years. The fishing season extends from August to March, but the September to December portion of the season is the best.

Fishing Methods.

Up to about 1895, oil sardines were caught in boat seines ('Paithu vala', 'Odam vala', etc.), drift nets ('Ozhuku vala', 'Kora vala', etc.) and cast nets, but other types of seines and gilling nets were later introduced on the West Coast. With the installation of fish oil and guano factories in 1908, these more effective new types of gear came into vogue fetching better prices for catches landed late in the evenings even beyond 10 p.m. when demand for fresh fish for consumption or curing would be the lowest. Moreover, the demand from the factories of even stale fish induced the fishermen to go for regular night fishing. The local names, dimensions and other specifications of the introduced nets are given below:—

Name.	Length in ft.	Width in ft.	Mesh size in inch.	Material.
I. Seine net:—				
1. Kolli vala:—				
(a) Mathikolli vala ..	60	18	$\frac{5}{8}$	Hemp
(b) Ailakolli vala ..	50	30	1	do.
2. Rampani ..	1,800	15-20	$\frac{1}{2}$ -1 $\frac{1}{2}$	do.
II. Gilling net:—				
1. Mathichala vala ..	36-90	12-18	$\frac{3}{8}$ - $\frac{5}{8}$	Cotton
2. Ailachala vala ..	48-60	30-36	$\frac{3}{8}$ -1	do.

1 & 2 Cited by Day (1865).

Two canoes with a total crew of fourteen carry in each boat half the seine net. When the shoal is sighted it is usual to pay out the net from both the canoes, which at the same time separate to form a semi-circle. When the shoal is encircled they move in towards each other and haul the net. The 'Kolli vala' is operated in the same manner, but the shoals are literally frightened and driven into the net by the loud noise and splashing made by the fishermen. 'Rampani', being a large shore seine, is operated by 70 to 80 men working from the shore with the assistance of 8 to 10 men on a large boat in the sea. Gilling nets are laid from two canoes in a slightly semi-circular fashion across the direction of the movement of the shoal, and the shoal driven towards them with plenty of noise. Cast nets are used from boats only, when large shoals are sighted at the surface.

Fishing Centres.

The important oil sardine centres of South Kanara and Malabar Districts on the West Coast are Malpe, Udiawar, Adakathbail, Madai, Cannanore, Tellicherry, Badagara, Quilandy, Calicut, Parapanangadi, Tanur, Ponnani, Blangad, Mannalam-kunnu and Kadapuram.

Fluctuations in the Fishery.

The capricious nature of the fishery on the South Kanara and Malabar Coasts will become obvious when we examine the following tabulated statements of the recorded quantities of fish oil and guano manufactured and exported during several years, and of cured fish and the estimated total landings of oil sardine during the last 25 years.

Export figures of sardine oil from the port of Cochin, the chief exporting centre of the Malabar Coast, from 1840-41 to 1863-64 (Day, 1865).

				Maunds ¹
Average for 5 years ending	1845-46	..	..	92
"	1850-51	..	..	5,020
Year	1855-56	..	..	63
"	1856-57	..	..	252
"	1857-58	..	..	95,900
"	1858-59	..	..	1,44,094
"	1859-60	..	..	1,86,400
"	1860-61	..	..	..
"	1861-62	..	..	..
"	1862-63	..	..	161
"	1863-64	..	..	2,07,488

It is evident that in the years 1857-58 to 1859-60 and 1863-64 the oil sardine fishery was good.

Statistics of fresh and sun-dried oil sardines used in coffee plantations and collected by agents of Messrs. Arbuthnot & Co., Ltd. (Thurston, 1900).

Seasons.	Fresh fish.	Sun-dried fish.
1890-91	4,620 Mds.	952 Mds.
1891-92	2,100 "	2,352 "
1892-93	4,424 "	4,060 "
1893-94	5,544 "	40,404 "
1894-95	1,176 "	49,392 "
1895-96	4,648 "	45,500 "
1896-97	504 "	..
1897-98	672 "	..

The success of the fishery between 1893 and 1896 is quite obvious.

¹ 28 Maunds = 1 Ton.

Quantities of oil sardines cured in fish-curing yards between 1896 and 1907 (Hornell, 1910).

						Maunds.
1896	..	..	..	..	..	3,87,295
1897	..	..	..	..	..	2,53,649
1898	..	..	..	..	..	28,702
1899	..	..	..	..	..	Poor year for sardines.
1900	..	..	..	..	..	57,880
1901	..	..	..	..	..	1,37,190
1902	..	..	..	..	..	2,19,760
1903	..	..	..	..	..	1,85,160
1904	..	..	..	..	..	1,33,200
1905	..	..	..	..	..	1,26,080
1906	..	..	..	..	..	1,48,259
1907	..	..	..	..	..	2,79,821

The immensity of the catches of oil sardines in 1899, which was considered as a poor year for sardines by Hornell (1910) can be well judged when compared to the catches of recent years. 5,320 maunds of oil sardines were landed in Ponnani circle, in the first week of December 1899 against 12,880 maunds in the first fortnight of December 1933 which was the best season for oil sardines since 1925. The prices provide a good index of the then prevailing abundance of oil sardines—15 and 200 sardines per pie in the poor and good years respectively of the nineties of the last century as against 20 sardines for a pie in the good year of 1933.

In the absence of records of landings of oil sardines for the period 1907-08 to 1924-25, the following statement showing the production of sardine oil and guano on the West Coast would give an approximate idea of the landings during the period:—

Seasons.	Oil in maunds.	Guano in maunds.
1906-07	..	1,60,216
1907-08	..	3,75,212
1908-09	..	..
1909-10	..	..
1910-11	..	5,264
1911-12	..	7,476
1912-13	..	52,416
1913-14	42,308	1,32,328
1914-15	..	..
1915-16	14	70
1916-17	..	..
1917-18	..	..
1918-19	..	..
1919-20	..	67,200
1920-21	..	42,000
1921-22	..	28,000
1922-23	3,36,000	8,96,000
1923-24	2,03,000	6,30,000
1924-25	56,000	1,12,000
1925-26	1,39,440	2,75,800

It would appear from the above that there have been good years and bad years for the sardine fishery throughout the entire period. It was reported¹ that the season

¹ Report of the Committee on Fisheries in Madras, 1929, 71.

of 1925-26 was a poor year when the quantity of guano produced amounted to 2,75,800 maunds; and the estimated total landings of oil sardine during the year were 11,92,449 maunds. If this quantity was considered as poor, one could very well imagine the magnitude of the oil sardine fishery in good seasons prior to 1925-26. For instance in 1922-23 the quantity of oil sardines utilized for manufacture of guano alone amounted to not less than 45 lakhs of maunds; this figure excludes the quantity consumed as fresh fish, utilized for curing, etc. Subsequently only in 1933-34 the landings had been heavy amounting to more than 19 lakhs of maunds when a relatively low quantity of 2,80,000 maunds of guano was manufactured.

Statement of estimated landings of oil sardines from the fish-curing yard registers in the South Kanara and Malabar Districts.

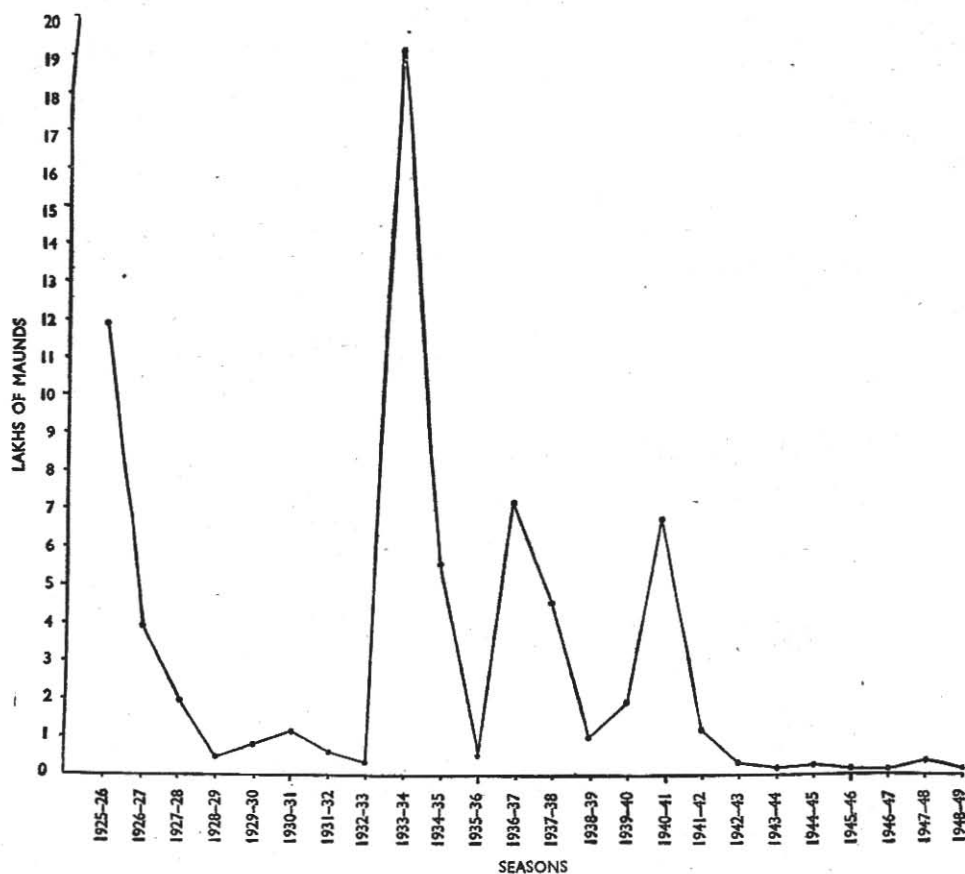
Seasons.	Oil sardines landed in maunds.		Total in maunds.
	South Kanara.	Malabar.	
1925-26	6,50,707	5,41,742	11,92,449
1926-27	74,021	3,22,626	3,96,647
1927-28	63,673	1,29,339	1,93,012
1928-29	8,465	39,968	48,433
1929-30	42,122	31,656	73,778
1930-31	4,824	1,11,048	1,15,872
1931-32	17,175	41,378	58,553
1932-33	212	29,901	30,113
1933-34	7,96,805	11,26,788	19,23,593
1934-35	10,796	5,47,414	5,58,210
1935-36	961	39,188	40,149
1936-37	1,22,365	6,05,361	7,27,726
1937-38	76,445	3,79,592	4,56,037
1938-39	66,873	24,576	91,449
1939-40	78,240	1,11,724	1,89,964
1940-41	2,90,603	3,86,406	6,77,009
1941-42	13,442	1,05,789	1,19,231
1942-43	690	23,948	24,638
1943-44	5,867	5,991	11,858
1944-45	17,472	123	17,595
1945-46	195	281	476
1946-47	30	207	237
1947-48	25,494	6,419	31,913
1948-49	6,645	1,144	7,789
1949-50	16,083	74,744	90,827

Taking into account that only 28.9 per cent of the landings were cured¹ in the fish-curing yards and also that 5 maunds of fish were required for the manufacture of 1 maund of guano,² landings of oil sardines had been as heavy as 1 million maunds or more in the years 1896-97, 1907-08, 1912-13, 1919-20, 1922-23, 1923-24, 1925-26 and 1933-34. The average annual catches of oil sardines were estimated by Nicholson (1918) as 28,00,000 maunds. The maximum quantity recorded during the period 1925-26 to 1948-49 was 19,23,593 maunds in 1933-34, much below Nicholson's estimate. And only in another season, 1925-26, the landings had exceeded one million maunds. The catches had fallen down to less than 50,000 maunds in 1928-29, 1932-33, 1935-36 and 1942-43 and thereafter. The lowest catch recorded prior

¹ Brochure on the Marketing of fish in India, 1948, 32

² *Madras Fish. Bull.*, Vol. 13, No. 3, 1922, 182.

to 1942-43 was 30,113 maunds in 1932-33, and in no year after 1941-42 had this figure been exceeded except in 1947-48 and then only by 1,800 maunds. Even though the fishery was fluctuating between 30,113 maunds in 1932-33 and 19,23,593 maunds in 1933-34, the fishery proved to be disastrous after 1941-42 (Graph).



Graph showing the fluctuations in the annual landings of the oil sardine in the South Kanara and Malabar Coasts from 1925-26 to 1948-49.

The average annual landings for the five-year period between 1937-38 and 1941-42 was 3,06,738 maunds against the lowest record of 237 maunds in 1946-47. The figures for the year 1949-50 show a rising tendency again with the landings about seven times the average for the bad years from 1942-43 to 1948-49.

Legislation.

The decline in the fishery in certain years may be attributed to (1) the fluctuations in abundance, (2) periodical migrations into offshore regions, (3) heavy natural mortality or overfishing, etc. The remedy for some of these will naturally result in evolving suitable legislation. The object of fishery legislation is only for the preservation of the continuity of the supply of fish and the object of the bye-laws is to prevent the destruction of undersized and immature fish so as to preserve a sufficient number of adults to secure a continuous supply. The biological ideal

would be to allow every individual fish to spawn at least once, but this is not practicable. It appears to us that the best means to achieve a continuous supply will be (1) to prevent the capture of fish below a certain size, (2) to establish close seasons, (3) to prohibit the capture or removal from a fishery of adults whilst engaged in reproduction, and (4) to prohibit the highly destructive methods of fishing.

The fluctuations in the oil sardine fishery had been attributed to various causes by workers on the subject. Day (1865) thought 'it must be left for future years to demonstrate whether the present increase of this fish oil trade is a healthy or an unhealthy stimulus due to the present high prices; for if the latter, the fisheries are being overworked, and the future loss will be great. The extreme violence of the South-West monsoon of course protects the fish from the commencement of June until September, but the periods of year at which the various species spawn, more extended observations on their arrival and departure, and a thorough examination into the fish captured as to whether the young are or not used for salting or fish oil, are objects which it would be very important to ascertain'. Thurston (1900), Hornell (1910) and Nicholson (1915) seem to have ignored altogether the overfishing problem. Sundara Raj¹ thought that the capture of large numbers of immature sardines would affect the fishery prejudicially and that overfishing of oil sardines would not arise as the existence of one or more races of oil sardines remained to be investigated. Devanesan (1943) and Devanesan and Chidambaram (1948) suggested respectively overfishing and the intrusion of an immature generation in the fishery as the probable causes of fluctuation. The variety of opinions expressed on the erratic nature of the fishery led to the study of the effect of the different kinds of nets employed. An investigation of this kind by one of us (K. C., unpublished) during the period 1933-34 to 1941-42 showed that only fish 15 cm. long or more were taken in the large meshed gilling net 'Chala vala' and immature sardines, less than 15 cm. long, in the boat seine 'Kolli vala'. That the 'Kolli vala' and 'Chala vala' introduced on the Malabar Coast about the year 1895 had a deleterious effect on the oil sardine fishery was realized by the fishermen who protested against the use of such nets and submitted petitions to Government. The use of these nets was also forbidden by fishermen's panchayat in some villages in Malabar. The fishermen believed that the noise made during the operation of the 'Mathikolli vala' and 'Mathichala vala' frightened the shoals of sardines and other fishes which receded to deeper waters.

Moreover, in the years of abundance from 1907 onwards, as shown in the statements given above, it would appear that small and immature sardines largely contributed to the fishery and the causes for the large demand for sardines were the high oil content of even small sized sardines below 15 cm. in length and the high prices offered by the oil and guano factories for such small sized fishes. The concentrated efforts made by fishermen, leading also to increased night fishing, to meet this demand may have affected the stock to a considerable extent apart from a fortuitous combination of unfavourable conditions in the sea. Examination of a few samples of oil sardines from Aden, Muscat, Karachi, Bombay and Karwar by Devanesan and Chidambaram (1943, abstract) showed that more than one race might occur but it needs careful examination.

As a result of consideration of the several different factors involved the Government of Madras introduced restrictive legislation in 1943 in the Malabar and South Kanara Districts. The main clauses relate to the prohibition of (1) the use of 'Mathikolli vala', during the fishing season from August to April, (2) the use of 'Mathichala vala' during the spawning period in August and September, and (3) the landings of immature oil sardines below 15 cm. not exceeding a total weight of 1 maund from any single boat during the fishing season. The legislation was extended for another two years from 1945 to prohibit the use of these nets for the capture of

¹ Administration Reports for the years 1933-34 and 1936-37 of the Madras Fisheries Department.

immature oil sardines throughout the year. The legislation lapsed in 1947, owing to practical difficulties encountered in the enforcement of the details of the regulation amongst which were (1) lack of preventive staff over a long coast line and (2) lack of similar legislation in adjacent States.

INDUSTRY.

Sardine as Food.

As oil sardines, like others of the clupeoid group, are subject to easy spoilage, only limited quantities are sold fresh for consumption. In Tanur on the Malabar Coast the fresh fish are packed with crushed ice in dealwood boxes and despatched to the bigger towns like Madras, Coimbatore, Bangalore and Trichy. Most of the fish, however, is cured with salt in proportions ranging from 6:1 and 9:1 and sun-dried. The Ratnagiri method of wet curing is practised in Kanara by using salt in the proportion of 3:1.

The following chemical composition of oil sardine has been recorded by Chari (1948);—

Edible portion	..	..	70%
Protein	..	..	19.57%
H ₂ O	..	..	76.49%
Ash	..	..	1.79%
P ₂ O ₅	..	..	0.79%
CaO	..	..	0.47%
Iron	..	..	6.09 mg. per 100 gm.
Fat ¹	..	..	2.03%

Sardines were canned successfully by a French canner, M. de Josselin, at Mahe for many years before the establishment in 1911 of a State cannery at Calicut to demonstrate the possibility of producing a quality canned product in India comparable to the imported varieties. The removal of this cannery in 1914 to Chaliyam at the mouth of the Beypore river facilitated supplies of fresh sardines and mackerel from the sea soon after capture. The preservation of fish in sardine oil, curry, tomato and mustard sauces was successfully tried for packing purposes and the products were in great demand both in and outside India; samples exhibited at the Wembley Exhibition, London, in 1924 received commendations but unfortunately many technical and practical difficulties encountered in post-war years resulted in the closing of the factory in 1933.

Sardine Oil and Guano.

A crude and primitive method of extraction of oil was in vogue on the Malabar Coast for many years. The sardines were treated with boiling water in an old canoe and left in the open sun to putrefy until the oil exuded out of the body of the fish was skimmed off. A slight improvement on this method was to allow the oil to collect in one half of the boat separated from the putrefying fish by a perforated iron sheet. By this method, not only was some residual oil left unextracted but the quality also suffered greatly.

The low grade fertilizer that was also produced by allowing the surplus fish to rot and dry on the beach was used to manure tobacco-fields but the manure lacked the valuable nitrogen and phosphate contents while the contained oil, which is injurious to the crop, was also lost.

Nicholson in 1908 introduced an improved method by which the sardines were thoroughly boiled in cauldrons over an open fire, and the resulting oil ladled out into buckets containing cold water and finally washed and dehydrated. The boiled

¹ The fat content is known to vary up to 15% depending on the size, sex and season.

fish were put in coir-mat bags and pressed in the indigenous screw-presses. The second grade oil thus pressed out was marketed separately or mixed with the former to form the industrial sardine oils. The residue in the bags was dehydrated by sun-drying to form the guano. A merchant of Cannanore adopted this method producing a brown oil and guano of good manurial value. His success and the improvements since made by the Madras Fisheries Department led to the opening of a number of small factories on the Malabar and South Kanara Coasts reaching the peak of 647 factories in 1922-23. The output of guano and oil for the year showed record figures of 8,96,000 maunds and 3,36,000 maunds respectively. The quantity of oil sardines used for this purpose must have been, on a modest estimate, in the neighbourhood of 44,80,000 maunds. This estimate does not take into account the quantities cured in yards, beach-dried as manure, or consumed as fresh fish. It is not difficult to imagine the magnitude of the shoals of oil sardines which should have appeared in the inshore waters throughout the Coast. The lure of high prices led to malpractices in manufacture which brought down the trade with Europe. In later years, this fall in trade coupled with the diminution in numbers of sardines helped to reduce the number of oil and guano factories, but this reduction could not cope with the next unexpected bumper crop of sardines in 1933-34, when only 301 factories were working, producing 2,80,000 maunds of guano and 64,960 maunds of oil. The disastrous failure of the fishery which followed the 1941-42 season resulted in reducing still further the number of factories in operation to 8 in 1946-47 and to zero in 1948-49.

The crude oil extracted in the earlier years of plenitude was used locally as a preservative for boats against weathering and ship-worm attacks. Two grades of refined oil were later obtained, of which the first grade yellow oil was used in the leather industry and in arsenals, and the second grade brown oil (1) in the jute and steel industries, (2) as lubricants, and (3) as the base for good quality insecticides. The refined sardine oil was found to compare very well with the Menhaden or the Japanese sardine oil as may be seen from the following (Nicholson, 1922):—

Oil.	Specific gravity.	Saponification value.	Iodine value.	Acid value.
Menhaden oil	0.931	193	160	7
Japanese sardine oil ..	0.933	195	181-187	10-34
Malabar sardine oil ..	0.88	196	156	3-9 } 12-53 }

Although sardine oil has a vitamin A content of 25% of that of cod-liver oil, it was observed to deteriorate rapidly under storage. For well over a century the bulk of the exports was to Great Britain, Germany, Turkey and other countries.

The high nitrogen and phosphate contents of fish guano have made it a valuable manure for cash crops and plantations. The difference in the composition between the crude beach-dried manure and the improved guano may be seen from the accompanying table (Nicholson, 1922):—

				Beach-dried manure.	Improved guano.
				%	%
Water .. ..	..	..	..	15	9.77
Nitrogen .. ..	..	..	..	6.8	8.31
Phosphoric acid ..	..	..	..	5.3	8.82
Potash .. ..	..	..	..	0.7	0.40
Total organic matter ..	..	..	..	60	66.28

The improved guano has been in great demand in coffee, tea, coconut, sugarcane and tobacco plantations and exported mostly to Colombo and to Japan.

Sardine Meal.

Sardine fish meal specially prepared in factories after the removal of the oil was in great demand with European live-stock owners. Its composition is as follows (Chari and Pai, 1948):—

					%
Moisture	..	..	..	..	9.68
Protein	..	..	..	..	65.27
Fat	..	..	..	..	9.54
Ash	..	..	..	..	14.77
P ₂ O ₅	..	..	..	..	5.79
CaO	..	..	..	..	6.01
NaCl	..	..	..	..	0.32
Insolubles	..	..	..	..	1.78
Unidentified	..	..	..	..	0.75

BIOLOGY.

The oil sardine, easily distinguished from other Indian sardines by its relatively long head and golden sheen, grows to a maximum size of 22-23 cm., the commercial size ranging from 12-20 cm. Its food consists of plankton with phytoplankton predominating. The spawning season extends roughly from August to November. The fish appears to be a prolific breeder judging from the large number of pelagic eggs (estimated at 75,000) liberated.

The oil sardines occur off the Coasts of Arabia and Iran (from collections received), Pakistan, India, Ceylon, Java and Bali Straits (Day, 1889 and Weber and Beaufort, 1913). The range of distribution in India extends from Kathiawar in the North, down the West Coast of India and rarely to the Coromandel and the Ganjam Coasts (Hornell and Nayudu, 1924) but shoaling in large numbers is known so far only on the Kanara and Malabar Coasts.

The oil sardine and the mackerel, which provide the largest fishery on the West Coast and contribute much to the welfare of the people, have attracted the attention of fishery workers in India for many years, more particularly to their fluctuations in occurrence. According to Hornell and Nayudu (1924) there are no local races among the oil sardines of Malabar and South Kanara, which attain sexual maturity when they are 15 cm. long and one year old. They move offshore prior to spawning from June to August which seems to result in high female mortality and the young enter shallow inshore waters in August and September to feed on the abundant plankton characteristic of the post-monsoon season. The fat of the oil sardine is apparently accumulated during September to December. The probable life span of sardine based on scale studies is two and a half years but growth appears to be slow in the second year. Devanesan (1943) confirmed some of Hornell and Nayudu's observations and contributed towards the knowledge relating to spawning and age determination. Nair's (1949) study of the growth rings on the otoliths makes it probable that the oil sardines attain maturity when they are two years old and 15 cm. long, and have a life span of three to four years. Chidambaram's (1950) close examination of the recorded data of measurements of oil sardines during the period 1936-43 lends support to Nair's findings. These data also reveal that indiscriminate fishing of immature sardines results in the proportionate reduction in the number of spawners in the fishery in succeeding years. The records also reveal that (1) small-sized sardines preponderate in years of abundance, (2) there is a correlation between the surface temperature and specific gravity of sea water and availability of food with

the movements and spawning of oil sardines and survival of the young, and (3) investigation on the occurrence of the sardines in the offshore regions is urgently necessary to appraise the causes of fluctuations in their abundance.

CONCLUSION.

It will be noticed that the available statistics furnished in this paper show an irregular fluctuation in abundance of oil sardines at intervals ranging between 2 to 6 years, between 1907 and 1942. It is also seen that the small-sized immature sardines have contributed largely to the success of the fishery in the years of abundance, viz. 1912-13, 1913-14, 1919-20 and 1922-23, and this has found corroboration in the fishery of 1933-34 and the following years.¹ It is of interest to record here that the recovery of the fishery on the West Coast of India in the current year is due mainly to the dominance of immature fish, 10 to 13 cm. long. As small sardines seem to contribute generally to the success of the fishery, the effect of indiscriminate fishing of immature sardines will be seen only in the succeeding years when fewer mature spawners will be available in the fishery. Apart from this factor of reduction in the number of spawners, there are other adverse factors influencing the rate of survival and recruitment to the stock such as unsuitable hydrological conditions, low survival rate of the larvae, and lack of the necessary food for the fry and juvenile sardines. The obvious remedy to combat the difficulties enumerated above is to introduce cautious, practicable and enforceable regulations to diminish the inroads made on immature sardines in the good fishing years, and to study simultaneously the effect of the enforcement on the biological and socio-economic factors.

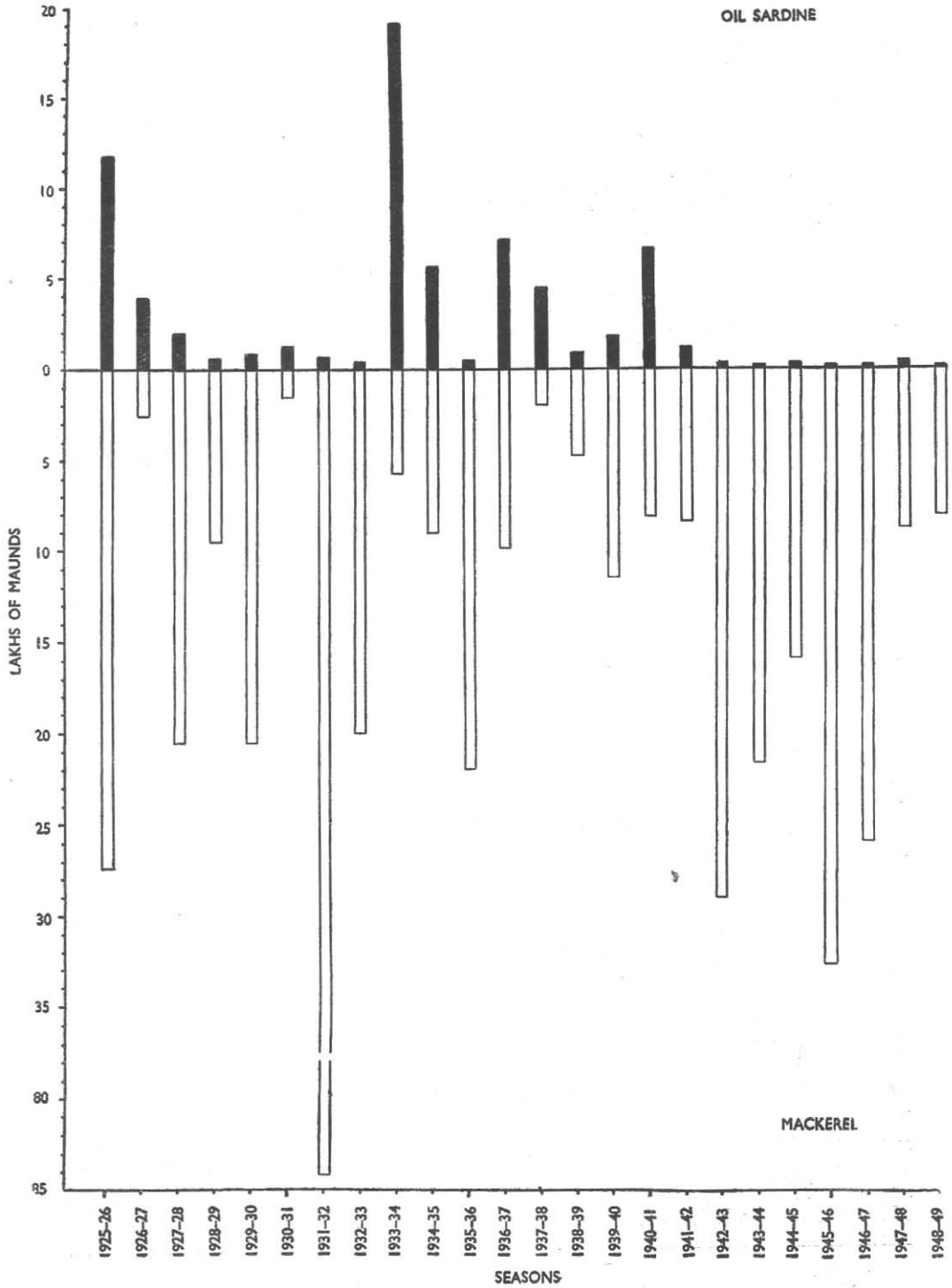
It is also necessary to study the influence of the fluctuating nature of the sardine fishery on other fisheries in the region. Hornell (1910) saw a connection between the marked diminution of sardine and the abundance of mackerel as in 1901, and drew attention to the fact that the sardines and mackerel were 'scarcely ever abundant in the same year; a good year for the one is usually coincident with an unsuccessful fishery for the other'. Such a relationship may be observed in the accompanying histogram based on the records of landings available for the period 1925-26 to 1948-49. Similar related inverse trends of variations in the catches of sardine and mackerel were observed till 1941-42 from which year onwards the oil sardine fishery gradually declined to its lowest ebb in 1946-47 from which a recovery is again noticeable, as for instance, in the exceptional abundance of oil sardines in the Karwar waters which have, for many years, been an area for mackerels alone, in the post-monsoon season of 1949-50.

In this connection it may be of interest to compare the recorded data of the sardine fisheries in other parts of the world. The sardine fishery of the Pacific Coast of North America extending from British Columbia to Mexico, accounted in 1936-37 for 7,90,000 tons, but the decline started after 1944 resulting in a financial crisis in the industry. In California the production dropped down to 1,24,000 tons in 1947-48. The 'worst sardine fishing year in living memory' was recorded in the Gulf of Aden for the season 1948-49.² In the Japanese and Korean waters there has been a marked decline in the availability of sardines since 1941 from which there has been no recovery till 1949; and it is stated³ that the present increased landings of fish in Japan and the Pacific Coast of U.S.A. are mainly due to the appearance of sardines. It is of interest to record the simultaneous decline and recovery of the world sardine fishery as seen in recent reports on this fishery in California, Japan and India, and it is likely that more or less similar factors affect the fishery of sardines as a whole in the Pacific and Indian Oceans.

¹ Administration Reports of the Madras Fisheries Department.

² 'Science's part in Colonial Progress'. *The Fishing News*, 37, No. 1895, 11.

³ *F.A.O. Fisheries Bulletin*, 3, No. 1, Jan.-Feb., 1950, 4



Histogram showing the relationship between the annual landings of the oil sardine and those of the mackerel in the South Kanara and Malabar Coasts from 1925-26 to 1948-49.

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Table showing the number of oil and guano factories and the quantities of oil and guano produced in South Kanara and Malabar from 1906 to 1949.

Years.	No. of factories. ¹	Oil in mds.	Guano in mds.
1906-07	..	..	1,60,216
1907-08	..	..	3,75,212
1908-09	1	..	..
1909-10	3	..	..
1910-11	9	..	5,264
1911-12	45	..	7,476
1912-13	45	..	52,416
1913-14	211	42,308	1,32,328
1914-15	211	..	..
1915-16	250	14	70
1916-17	..	..	..
1917-18	..	..	..
1918-19	358	..	..
1919-20	563	..	67,200
1920-21	646	..	42,000
1921-22	542	..	28,000
1922-23	647	3,36,000	8,96,000
1923-24	440	2,03,000	6,30,000
1924-25	515	56,000	1,12,000
1925-26	463	1,39,440	2,75,800
1926-27	504	17,920	58,800
1927-28	470	5,600	23,800
1928-29	282	1,960	30,800
1929-30	325	672	6,244
1930-31	236	1,820	4,396
1931-32	32	364	3,920
1932-33	96	15	560
1933-34	301	64,960	2,80,000
1934-35	..	..	..
1935-36	4	182	700
1936-37	103	12,572	62,580
1937-38	145	11,676	43,820
1938-39	56	1,022	7,616
1939-40	69	2,744	11,340
1940-41	203	12,628	57,568
1941-42	180	504	2,716
1942-43	186	140	1,456
1943-44	188	546	672
1944-45	178	298	546
1945-46	178	1	448
1946-47	166	..	896
1947-48	162	..	..
1948-49	162	..	..

¹ The figures show the number of factories in existence including those in operation.

Table showing the estimated landings of oil sardines and mackerels in South Kanara and Malabar from 1925 to 1949.

Years.	Oil sardines in mds.	Mackerels in mds.
1925-26	11,92,449	27,41,541
1926-27	3,96,647	2,60,145
1927-28	1,93,012	20,73,090
1928-29	48,433	9,70,329
1929-30	73,778	20,90,603
1930-31	1,15,872	1,49,909
1931-32	58,553	84,26,860
1932-33	30,113	20,09,661
1933-34	19,23,593	5,97,757
1934-35	5,58,210	9,11,072
1935-36	40,149	22,35,427
1936-37	7,27,726	10,07,046
1937-38	4,56,037	2,10,680
1938-39	91,449	4,88,702
1939-40	1,89,964	11,60,482
1940-41	6,77,009	8,23,934
1941-42	1,19,231	8,63,722
1942-43	24,638	29,46,567
1943-44	11,858	21,85,796
1944-45	17,595	16,08,870
1945-46	476	33,06,709
1946-47	237	26,29,645
1947-48	31,913	8,84,412
1948-49	7,789	8,13,265

Table showing the landings of oil sardines in South Kanara and Malabar for the year 1949-50.

Months.	South Kanara.	Malabar.
	Maunds.	Maunds.
July, 1949 .. ..	..	..
August, 1949 .. ..	..	..
September, 1949 .. ..	..	100
October, 1949 .. ..	..	695
November, 1949 .. ..	..	19,115
December, 1949	11,676	23,017
January, 1950	3,516	16,118
February, 1950	307	7,154
March, 1950	574	6,375
April, 1950	10	1,765
May, 1950	110
June, 1950	295
Total	16,083	74,744
Grand Total	90,827	

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